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Simulation of Computer-Assisted Instruction (Formerly Developing Concepts in Physics and Geography at the Senior High School Level by Simulation of Computer-Assisted Instruction). Final Report.

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In an attempt to determine whether information and skills necessary to use a university library could be taught in high schools by a method of branching pictorial programing, a series of experiments were conducted with the assistance of high school seniors and college freshmen, juniors and seniors. In Experiment 1, Carbondale High School Students were compared with the College Picture and Print Group. Experiment 2 compared University School and College, Picture-Print and Audio only. Experiment 3 was a comparison of high school classes against the college group on by-passes attempted and successful by-passes. Comparison of University School and College Audio-only was the subject of the fourth experiment. Experiment 5 was concerned with Carbondale Community High School and College, Picture-Print, and grade point. The last experiment, number 6, was a comparison of Picture-Print and Picture-Audio high school groups by GPA levels. Conclusions are detailed at the end of each experiment, and there is an appendix of 15 tables detailing scores in the experiments. (Author/CO)

ED0 32758

SIMULATION OF COMPUTER-ASSISTED INSTRUCTION (FORMERLY DEVELOPING CONCEPTS IN PHYSICS AND GEOGRAPHY AT THE SENIOR HIGH SCHOOL LEVEL BY A SIMULATION OF COMPUTER-ASSISTED INSTRUCTION)

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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Final Report

The work reported herein was performed pursuant to Contract No. OEC 3-7-062875-3056 with the United States Department of Health, Education and Welfare, Office of Education

for the

Central Midwestern Regional Educational Laboratory, Inc.
10646 St. Charles Rock Road
St. Ann, Missouri 63074

Submitted by

Southern Illinois University
Department of Instructional Materials
Carbondale, Illinois
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Background

Computer-assisted instruction is becoming important in all levels of education. Since 1960 the senior author and Mr. Grosvenor Rust conducted eleven controlled experiments in branching pictorial programming simulating computer-assisted instruction.[1] The subjects were college freshmen, juniors, and seniors. The results of these 11 studies are compared in the 9 experiments reported here with parallel experiments on high school seniors. The purpose of the present series was to determine if information and skills necessary to use a university library could be taught in high school by this method of branching pictorial programming.

The four branching programs used in both series of experiments contain basic information on the card catalog, encyclopedias and dictionaries, periodicals, and indexes. Programmers and library consultants devised the program through the usual programming system of setting objectives, writing criterion frames and instruction frames, devising diagnostic questions, writing the wrong answer frames and remedial circuits associated with them, and providing by-passes. Special devices for particular experiments were inserted as needed. Programs went through the usual routine of multiple pretesting revision. The paper and pencil

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[1]Wendt, McCoy, & Rust, "A Study to Determine the Extent to Which Instruction to University Freshmen in the Use of the Library Can Be Turned Over to Teaching Machines." U.SOE Grant No. 7-11-076.00, NDEA Title VII.

Wendt & Rust, "To Test Refinements in Intrinsic Programming in Pictorial, audio and Performance Frames to Maximize the Probability of Desired Terminal Behavior." U.SOE Grant No.7-23-0907-189, NDEA Title VII.

criterion test was established by using professional librarians as subjects and consultation with other professional librarians.

All instruction frames were combined kodachrome picture and print projected as slides on a screen in front of the subject and in some experiments the print content was eliminated and presented by audio tape to the subject while he was looking at the colored picture. Both the slide projectors and the audio tape player of course had to be random access as is the case with CAI.

A special feature of the programs were performance frames. At points during the program a frame called for the student to stop the program and perform a skill simulating the terminal skill to be required of the subject. For example, after some instruction in the card catalog the subject was directed to find a particular catalog card in the sample catalog tray before him. A diagnostic question then checked his answer. If wrong, he was directed to a wrong answer frame which explained what he had done wrong and returned him to the performance frame. Other simulation skills required of the subject were finding an item in a dictionary or in an encyclopedia, locating a particular periodical or a book, or getting information out of an appropriate index. The performance frames were designed in accordance to the most basic principle in programming--to help the learner exhibit the specified terminal behavior in the shortest time.

To measure terminal behavior a performance rating scale was devised and standardized. This consisted of assignments given to each subject on the floor of the library; in carrying out these assignments actions of the subject were rated by an observer.

Brief Summary of Previous Results

The pictorial frames and the performance frames were found to have no significant effect on the paper and pencil criterion test but highly a significant effect on the performance rating scale.

Method

Subjects used in the present experiment were seniors at the Carbondale Community High School and at the University Laboratory School. The original plan was to use only students from CCHS but signed permission was required from each parent and so many parents refused this permission that not enough subjects were available. It was necessary, therefore, to run additional experiments using the laboratory school.

Each student sat before a console facing a screen in a small room. Behind him in a sound insulated room four Sarkes-Tarzian projectors were controlled by the key board in front of the subject so that any individual slides could be projected on the screen by pushing the appropriate buttons. Each frame on the screen gave the subject the number of the next frame to which he should proceed. In the diagnostic questions each alternative answer gave the subject a different frame number to which to proceed. The program and equipment simulates the IBM 1500 CAI System in that both audio and pictorial stimuli are presented in any random order necessary through the use of the random access projectors and tape recorder. A print-out kept a record of each student's route through the many branches, and a timer kept a record of the time spent on each decision

and total time. Each program was charted like system on paper and each subject's progress could be graphically portrayed.

For the performance rating scale tests on the floor of the university library all the high school students, both CCHS and Laboratory School, were brought o the university library.

All students were given a pretest and a post test which consisted of two forms of the paper and pencil criterion test.

Experiment 1. Comparison of Carbondale Community High School and College Picture and Print Group

In the branching program all instruction frames consisted of a kodachrome projected picture accompanied by a few words of print. In most cases the picture and the print were of equal importance to the instructional value of the frame. To test the unique contribution of the pictures, in one program the pictures were eliminated, their content being translated into print which was added to the print already in the frame. This version of the program was called Print-only. In the previous series of experiments one group of college students which viewed the Print-only program while another used the regular program which included kodachrome photographs. There was no significant difference between the groups on the paper-and-pencil criterion test.

In the present experiment two similar groups of seniors from the Carbondale Community High School were used. One group (N=12) used the Print-only program while the other (N=15) used the Picture-print program.

Analysis 1A Gain Scores

An analysis of variance was used on these four groups on their gain scores, the groups consisting of the two CCHS groups and the previous two college groups. The only significant value of F was between groups, indicating that the high school students had lower gain scores. (See Table 1)

Analysis 1B Rating Scale Scores

The same four groups were compared on their scores on the performance rating scale measuring their carrying out of actual assignments on the floor of the library. An analysis of variance showed that there was no significant difference between the group, between the methods, or in the interaction.

Analysis 1C Program time

The four groups were compared on the basis of the total time it took the students to complete the program. An analysis of variance again showed no significant difference between the groups, between the methods, or in the interaction.

Experiment 1 - Conclusions

This experiment showed no difference between the high school seniors and the college students in the effectiveness of the pictures in the instruction frames. The high school seniors, like the college students, did not show any difference between the print-only methods and the picture-print methods as evaluated by the pencil paper criterion test, they merely scored lower. In the performance rating scale the college students had previously shown a significant difference in favor of the picture group but

no difference was noted in the high school seniors. With the college students it was hypothicated that although the pictures added nothing to the ability of the student to make a verbal response to the paper and pencil test, it made an important difference in the much more important criterion of terminal behavior in the library. If anything, high school students should be helped more by pictorial simulation of the terminal behavior than older college students, but this was not the case. At this stage of this type of investigation no possible explanation can be suggested.

In the matter of total program time required to complete the program the high school seniors showed the same lack of difference between the Print-only and the Picture-print group as the college students had previously shown.

Experiment 2. Comparison of University School and College, Picture-print and Audio-only

Analysis 2 Criterion Test

In a previous experiment with college students the print content of the Picture-print instruction frames was transferred to a random-access tape player. Thus the experimental students saw a kodachrome picture on the screen at the same time that they heard on earphones the words previously appearing on the screen as print with the picture. This version was referred to as the Audio-only version. A group of 29 seniors from the University High School was exposed to program 1 on Cataloging in this version. A comparable group of 21 University High

School seniors were exposed to the same program in its original Picture-print version.

Analysis 2A Gain Scores

An analysis of variance of these groups showed no significance between the levels of the methods and no significant difference in the interaction.

Analysis 2B Rating Scale

The analysis of variance by rating scale scores showed a significance in the interaction. A further analysis by t-tests showed that this significance arose from differences in methods, that is, the Picture-print did significantly better in the performance rating scales than the Audio-only group.

Analysis 2C Program Time

The ratio for the four groups again showed a significant difference in the interaction and this was traced by t-tests to the difference between the high school students and the college students.

Analysis 2D By-passes Attempted

The significant interaction by an F-ratio was followed by t-test which showed that the significant difference was caused by more by-passes attempted by the high school students than by the college students.

Analysis 2E By-pass Success/attempts

Again the significant more successes in by-passes by the high school students than by the college students.

Experiment 2 - Conclusions

Again there was no significant difference between the two groups as measured by the paper and pencil criterion test, but there were significant differences by any other measure--rating scale score, program time, by-passes attempted, and by-passes successfully achieved. Apparently the imparting of informatin by two sensory modes simultaneously, visual auditory, was not superior to the pure visual approach. Possibly the important factor is that the listener must receive an audio message at the given speed of the message but a reader can read as fast as he desires.

Experiment 3. Comparison of combined high school classes against the college group on by-passes attempted and by-passes success

A group of 28 college juniors and seniors in 1965 provided data for the number of by-passes attempted and the number of successes after such attempts. To compare with their record the data of 15 seniors from the Carbondale Community High School and from 28 seniors in the University School were combined on the same two records of performance.

Analysis 3A By-Passes Attempted

T-tests comparing the high school seniors and the college students produced a value t=2.2271 which was significant to 5% level of confidence. The college students attempted many more by-passes than the high school students.

Analysis 3B The Ratio of By-pass Successes to By-pass Attempts

On this measure there was no significant difference between the high school and the college group.

Experiment 3 - Conclusions

Apparently the high school students even though they attempted many less by-passes were just as successful in those by-passes which they did attempt. The ratio of by-pass successes to by-passes attempts was originally devised in order to get at some of the factors that induce subjects to try by-passes. Anormalities had previously been discovered in this matter. One was that there was no relation between by-passes attempted by college students and their pre-test, or to their grade point average or general ability. Similarly, many students who attempted a by-pass and after answering the entry question had earned the right to by-pass, requested to be put back on the main line, thereby throwing away the priviledge of the by-pass which they had earned. All these anormalities indicated some factors which were unknown. One experiment employed Rotter's Incomplete Sentence blank in an attempt to isolate some factors which might operating, but only two were slightly effective. The basic factors involving the decision to try by-passes is therefore still unknown.

Experiment 4. Comparison of University School and College Audio-only

As explained previously, Program 1 was transformed into an audio program by transferring the print appearing on the

screen to a random access tape player. The subject therefore saw the kodachrome picture on the screen and heard a voice giving the material that was formerly print.

Analysis 4A Gain Scores

The t-test revealed a value of 1.1375 which was not significant.

Analysis 4B Program Time

The t value was 3.9250 which was significant at the 1% level of confidence in favor of the college group.

Experiment 4 - Conclusions

From the results it appears that high school group attained an equally high level of competence on the paper and pencil criterion test as the college students, but took significantly longer to do so. This is in conformance with the general results obtained from programmed instruction, after programmed instruction students tend to have smaller variance in criterion scores because one of the great advantages of programmed instruction is that each student no matter what his ability can proceed at his own rate of speed. Apparently the fact that the audio portion of the program was paced had little effect on keeping the program times more nearly uniform. Although the audio components may have made the time spent on instruction frames more uniform greater variability was encountered on the diagnostic question frames and the resulting wrong answer circuits.

Experiment 5. Carbondale Community High School and College, Picture-print, grade point

A group of seniors from CCHS (n=15) were compared with the college group in 1964 (n=18) both groups seeing the standard picture-print version, but each group dicotomized at a grade point average of 3.51 and above or 3.50 and below.

Analysis 5 Pre-test Scores

Analysis of variance showed no significant difference either between groups, between levels, or in interaction.

Analysis 5A Gain Scores

An analysis of variance indicated that an F of 4.57 was significant at the 5% level of confidence. There was no significant difference between the two groups nor in the interaction. A subsequent t-test by levels within each group showed no significant differences.

Analysis 5B Rating Scale

An analysis of variance by levels again showed a significant difference between the groups but not between the levels, nor in interaction. Subsequent t-tests showed a difference between the groups at the 5% level of confidence.

Analysis 5C Program Time

An Analysis of variance showed that there was no significant difference between the groups, between the levels, nor in interaction.

Analysis 5D Rating Scale Time

This term means the time required by the subjects to complete the performance tests. An analysis of variance showed no significant difference either between groups, or between levels, or in interaction.

Experiment 5 - Conclusions

Of all the tests of this experiment only two were found to be significant, they were at the 5% level of confidence and they are difficult to interpret. For example, the significant between levels on the gain scores probably has little relation to the pictorial program involved and is probably entirely dependent upon the ability of the students in both groups. The other significant difference was on rating scale scores 2nd was in favor of the college group. This means that the college students performed better on the floor of the library after the program than the high school seniors did. One might conclude that the pictorial content of the program had less effect than providing the high school seniors with a simulation of the terminal behavior that was to be required of them.

Experiment 6. A comparison of Picture-print versus Picture-audio high school groups by GPA levels.

One group of University High School seniors (N=45) was exposed to the usual Picture-print version of the program another group (N=18) was exposed to the Picture-audio program. Both were versions of Program 1 on cataloging. Both groups were divided at a grade point average of 3.6 and below or a grade point average of 4.0 and above.

Analysis 6A Gain Scores

An analysis of variance showed no significant difference either between groups, between levels, or in interaction.

Analysis 6B Rating Scale Scores

Analysis of variance gave a value of 35.18 between groups in favor of the audio group. This was significant difference between levels or in interaction.

Analysis 6C Program Time

Here the analysis of variance showed a significant difference at the 5% level between groups, at the 1% level between levels, and at the 1% level in interaction. Subsequent t-test showed that the upper ability students profited more from the regular picture-print version and the lower ability students profited more from the picture-audio version.

Analysis 6D Rating Scale Time

Analysis of variance showed no significant difference between levels or in interaction but a significance difference at the 1% level between groups.

Experiment 6 - Conclusions

These varied results are very difficult to interpret in a systematic manner. As before gain scores on the paper and pencil criterion test apparently were a poor measure of the effectiveness of any particular version of the program of the ability of the students. In rating scale scores the audio group did significantly better. In program time the picture group

seemed to be superior to the audio group and at the same time students that had a higher grade point average were better than those with a lower GPA. Finally, the Picture-print seemed to help the superior students more and the Picture-audio version seemed to help the less able students. Several factors seem to be at work: the paper and pencil test is a poor criterion; the superior students, being good readers would naturally profit more from the Picture-print version than the Picture-audio version whereas the less able students would profit more from the slow pacing of the picture-audio version. No conclusions can be drawn at all concerning the value of one sensory mode of instruction versus two.

Table 1

Experiment 1-A

Gain Scores

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	77	3326.15	43.19	1.08
A Between groups	1	237.76	237.76	5.96*
B Between method	1	78.08	78.08	1.95
AB Interaction	1	60.09	60.09	1.50
ERROR	74	2950.20	39.86	1.50

*Significant at .05

Table 2

Experiment 1-B

Rating Scale Scores

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	77	22751.53	295.47	1.00
A	1	220.87	220.87	.75
B	1	4.73	4.73	.01
AB	1	870.20	870.20	2.97
ERROR	74	21655.72	292.64	

Table 3

Experiment 1-C

Program Time

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	77	40801.03	529.88	1.02
A	1	770.00	770.00	1.48
B	1	698.26	698.26	1.34
AB	1	975.56	975.56	1.88
ERROR	74	38357.21	518.34	

Table 4

Experiment 2

ANALYSIS	Mean-X	Mean-Y	SD-X	SD-Y	t
2A Gain Scores	10.190	7.931	5.464	5.161	1.46030
2B Rating Scale	67.428	73.413	10.274	9.994	-2.02376*
2C Program Time	86.666	66.655	11.572	15.154	4.97146**
2D By-passes attempted	5.666	7.586	2.415	1.637	-3.28015**
2E By-pass success/attempts	.317	.497	.232	.196	-2.89840**

*Significant at .05 ** Significant at .01

Table 5

Experiment 3

ANALYSIS	Mean-X	Mean-Y	SD-X	SD-Y	t
3A By-passes attempted	7.886	10.921	1.528	8.774	-2.22717*
3B By-pass success/attempted	.532	.577	.204	.369	-.68657

*Significant at 5%

Table 6

Experiment 4

ANALYSIS	Mean-X	Mean-Y	SD-X	SD-Y	t
4A Gain scores	3338.696	2110.190	112.607	5.464	1.13754
4B Program Time	62.939	82.619	13.970	22.184	-3.92502**

**Significant at .01

Table 7

Experiment 5

Pre-test

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	32	723.11	22.59	.93
A	1	.17	.17	0.00
B	1	15.15	15.15	.62
AB	1	7.06	7.06	.29
ERROR	29	700.72	24.16	

Table 8

Experiment 5-A

Gain Scores

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	32	1420.24	44.38	1.21
A	1	128.65	128.65	3.52
B	1	166.99	166.99	4.57*
AB	1	66.29	66.29	1.81
ERROR	29	1058.29	36.49	

* Significant at .05

Mean-X	Mean-Y	SD-X	SD-Y	t
34.666	30.722	7.345	5.623	1.69193

Table 9

Experiment 5-B

Rating Scale

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	32	10306.54	322.07	1.16
A	1	1684.80	1684.80	6.07*
B	1	575.60	575.60	2.07
AB	1	1.81	1.81	0.00
ERROR	29	8044.32	277.39	

*Significant at .05

Mean-X	Mean-Y	SD-X	SD-Y	t
60.739	75.700	19.065	9.129	-2.29354

Table 10

Experiment 5-C

Program Time

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	32	25552.96	798.58	1.01
A	1	991.37	991.37	1.26
B	1	1614.06	1614.06	2.05
AB	1	130.73	130.73	.16
ERROR	29	22816.80	786.78	

Table 11

Experiment 5-D

Rating Scale Time

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	32	4472.96	139.78	1.04
A	1	380.06	380.06	2.84
B	1	140.16	140.16	1.05
AB	1	84.74	84.74	.63
ERROR	29	3867.99	33.37	

Table 12

Experiment 6-A

Gain Scores

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	42	1340.79	31.92	.97
A	1	7.19	7.19	.22
B	1	56.31	56.31	1.72
AB	1	3.86	3.86	.11
ERROR	39	1273.41	32.65	

Table 13

Experiment 6-B

Rating Scale Scores

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	42	4283.16	101.98	1.81
A	1	1975.41	1975.41	35.18**
B	1	85.18	85.18	1.51
AB	1	32.75	32.75	.58

** Significant at .01

Table 14

Experiment 6-C

Program Time

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	42	11262.79	268.16	1.77
A	1	892.61	892.61	5.91*
B	1	2720.61	2720.61	18.04**
AB	1	1769.09	1769.09	11.73**
ERROR	39	5880.47	150.78	

* Significant at .05 ** Significant at .01

Table 15

Experiment 6-D

Rating Scale Time

ANALYSIS OF VARIANCE TABLE (UNEQUAL N)

Source	DF	SS	MS	F
TOTAL	42	2190.00	52.14	1.27
A	1	569.70	569.70	13.89**
B	1	9.51	9.51	.23
AB	1	11.32	11.32	.27
ERROR	39	1599.44	41.01	

** Significant at .01

	Mean-X	Mean-Y	SD-X	SD-Y	t
Group	81.500	69.217	13.132	17.018	2.55817
Method	67.600	85.111	15.553	11.498	-3.95109